TROPICAL CYCLONES IN AUSTRALIA AND THE SOUTH PACIFIC AND INDIAN OCEANS.

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The tropical cyclones of the West Indian region, the Far East and the Bay of Bengal are fairly well known. The inadequacy of published information as to similar storms in other parts of the tropics is perhaps well recognized and it may be necessary at times to deal with assumptions, as witness the following: A recent writer, somewhat of a specialist on Pacific storms, felt able only to surmise as to the monthly distribution of hurricanes in the south Pacific.[1]

With the aid of grants from Yale and Indiana Universities, and the Bishop Museum of Honolulu. the writer has gathered information as to tropical disturbances and their effects. Several island groups were visited in the Pacific and much information was also obtained in Australia and in the Far East. Conferences were had with Father Algué of Manila, Father Froc of Zi-ka-wei, Shanghai, and with Directors Okada of the Japanese Imperial Marine Observatory, Kobe, and Claxton of the Royal Observatory, Hongkong. Published and unpublished information has been gathered from many sources, including foreign and domestic libraries. A bulletin has been prepared on "Australian hurricanes and related storms with an appendix on hurricanes in the South Pacific," which is to be published soon by the Australian Commonwealth Bureau of Meteorology. In it over 500 hurricanes are listed with concise information about each; tracks of 200 hurricanes affecting Australia are traced and somewhat extensive studies are made of the distribution and characteristics of hurricanes in and near Australia, and in the south Pacific. In the following pages some of the material in this bulletin is summarized and numerous facts not appropriately included there are added, especially as to the storminess in the south Indian Ocean.

Tropical cyclones, there commonly called hurricanes, have been recorded in every month of the year in the south Pacific, in all but August in Australia, and in all but August and September in the south Indian Ocean. However, they are rare from May to October, and not common in November or April. The hurricane season for most of the region is the four-month period December to March inclusive, but there is considerable variation as to the stormiest month, as will appear later.

As to the frequency of storms: Two serious questions arise, first, the incompleteness of the records and second, as to what severity of storm is required in order to have it merit inclusion. Information is very scanty in respect to most of the region, for most years. In order to arrive at an estimate of the total frequency which will not be woefully inadequate, it seems necessary to consider only the periods for which fairly full records are available. Also it seems wise to do as Froc and Algué[2] have done, include all well-developed tropical cyclones even if winds of hurricane force are not rcorded, for as they remark, it is not known how soon such a storm will develop into a destructive typhoon, or whether or not it was destructive along part of its little known course.

After making conservative allowance for the incompleteness of the record, and counting all gale-producing storms, not only true hurricanes, it appears probable that on the average fully a dozen tropical cyclones occur annually in the 60° of the south Pacific west of the Low or Taumotu Archipelago (long. 140° W.), about as many in the 60° of longitude which includes Australia (100° to 160° E.) and probably somewhat more than a dozen in the 60° of the south Indian Ocean between Africa and the Australian coastal waters (long. 40° to 100° E.). The evidence for these conclusions is given in some detail beyond. Hence, the indications are that about as many tropical cyclonic storms occur annually in this half of the southern Tropics (longitudes 40° E. to 140° W.) as one recent authority reports from the chief storm areas of the Northern Hemisphere (34 storms a year, including many which do not attain hurricane force.)[3]

Now to take up the storminess of the three great parts of the Southern Hemisphere treated in this article. The storminess of the South Pacific will be considered first. The occurrence by island groups and the monthly distribution of tropical hurricanes in the South Pacific from New Caledonia to the Low or Taumotu Archipelago inclusive is considered in Table 1. It is based on a total of 246 hurricanes, but as some storms affected more than one group, the sum of the monthly figures totals 292.

TABLE 1.—*Tropical cyclones in the south Pacific, longitudes 160° E. to 140° W., by island groups.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total number of recorded storms.	Indicated average annual frequency.
Fiji	21	15	20	4	....	....	....	....	....	....	1	13	74	2
Tonga	16	7	14	6	1	....	....	....	....	....	3	3	50	2
Samoa	10	2	8	2	....	....	....	....	....	....	1	6	29	2-3
North Hebrides	11	9	9	2	1	....	....	....	....	1	3	1	37	2
North Caledonia	11	11	10	....	....	....	1	....	1	2	....	4	40	3
Norfolk	4	7	7	2	....	2	....	1	....	2	....	....	25	2
Pautomas	3	2	1	....	....	....	....	....	1	....	....	....	7	.5
Tahiti	3	1	....	....	....	....	....	....	1	....	....	3	8	.2
Solomons	2	1	2	....	....	....	....	....	....	....	....	1	6	.2
Cook Islands	2	5	2	2	....	....	....	....	....	....	....	5	16	.5
Totals	83	60	73	18	2	2	1	1	3	5	8	36	292	.....

It will be seen by Table 1 that the hurricane season extends from December to April, inclusive. During this five-month period about 95 per cent of the recorded storms have occurred. January has about 30 per cent of all storms, March about 25 per cent, February about 20 per cent, December about 13 per cent, April about 6 per cent, November about 2 per cent. The other six months combined make up only about 4 per cent of the storms. The monthly distribution differs, however, in several island groups. While in most January is the stormiest month and March is second,[4] in four groups March is equal to or ahead of January, and in two groups more storms have been recorded in February than in either January or March.

The number of recorded storms varies greatly. For example, in some groups and decades the information is fairly complete, for others it is fragmentary. The list for Fiji is relatively long; I spent a month there in 1921 gathering information as to storms from observers who reside in different parts of the group, and from the Government records, and newspapers. The Tonga list

[1] E. A. Beals: Barometric pressure, winds, and storms of the Pacific Ocean, *Bull. 9 of the Scripps Institution*, pp. 65-75. December, 1919.

[2] L. Froc: *L'Atmosphere en Extreme-Orient*, 2d edition, 1920, and *Atlas of the Tracks of 620 Typhoons*, 1918. J. Algué: *The Cyclones of the Far East*, 1904.

[3] Fassig, O. L.: *Weather Bureau Bulletin X*, p. 15.

[4] If the months be corrected for unequal length the differences are not so striking.—EDITOR.

comes chiefly from four sources. A short list of especially disastrous storms supplied me by the premier, a list gathered by German investigators and published in the *Segelhandbuch für den Stillen Ozean*,[5] and thirdly a list supplied me by Rev. E. E. Collocott made up from records of the Missionary College at Nukalofa. Information as to a number of additional hurricanes was gathered from sundry sources, chiefly from residents in Fiji, and from newspapers in Fiji and Australia.

The Samoan list is chiefly that compiled by the Germans and printed in the *Segelhandbuch*. The lists for New Caledonia and Norfolk Island come chiefly from information supplied by the Australian Meteorological Bureau. Barometric readings are cabled daily from these islands to Australia, and the Australian weather map extends that distance east. I studied the Australian daily weather maps for the years 1892–1921 while working in the central office of the bureau at Melbourne in 1921.

Information as to the hurricanes of other groups comes chiefly from the list in the *Segelhandbuch*, supplemented by storms mentioned in recent (1908 and 1920) editions of the Pacific Island Pilots (United States Hydrographic Office) and the Pacific Islands Sailing Directions (British). Data as to a few other storms were obtained elsewhere.

The first extensive list of hurricanes in the south Pacific is that of E. Knipping, 1893.[6] It increased Dobson's list of 24[7] to 120. In the *Segelhandbuch (loc. cit.*, 1897), the total was increased by 10. Schück studied the time and place distribution in his *Zur Kenntnis der Wirbelstürme*,[8] and added 5 to the list, bringing it to 135. I have brought it to 246 in the bulletin already mentioned, where facts as to each storm are given, together with reference to the sources of information.

The final column of Table 1 consists of estimates as to the probable annual frequency of severe tropical cyclones. It is based upon the decades or series of years for which the information appears fairly complete. For example, for the New Hebrides, during the 26 years 1867–1893, 22 hurricanes are reported, but there is a gap of 8 years with no record. On this basis it appears that somewhat more than 1 hurricane is to be expected annually. But since two storms a year have been recorded in many years, and as the island groups of similar size to the east and west have averages of two or more a year, it seems reasonable to surmise that an average of nearly two storms may be expected to affect some part of the New Hebrides annually. Likewise although Table 1 mentions only 7 hurricanes from the Low Archipelago, the fact that four occurred in one 4-year period and three in another 4-year period suggests that hurricanes are not infrequent in this group. A scientist who has studied in the group and in the Marquesas reports that they occurred not rarely in both groups.[9]

The total of the several estimates of the number of hurricanes per year is 15 storms a year for island groups. However, perhaps 2 or 3 storms cross two or more groups of islands and thus appear more than once in Table 1. Thus the total number of severe tropical cyclones damaging these island groups appears to average about 12 a year. However, more than a dozen hurricanes probably occur annually in this general region, for doubtless a few unrecorded storms pass between the groups each year, especially between Fiji and the New Hebrides and between Tonga and Samoa and Cook Islands.

The occurrence of recorded hurricanes in the south Pacific by years and by months is shown in Table 2.

TABLE 2.—*Recorded hurricanes in south Pacific, by years and months, longitudes 160° E. to 140° W.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Month not given.	Total.
1789		1												1
1819					1								1	1
1830			1										1	2
1831												1		1
1833	1		1											2
1834													1	1
1835											1			1
1836													1	1
1837													1	1
1838													1	1
1839		1											1	2
1840		1										2	1	4
1842												1		1
1843												1		1
1845	1													1
1846			2											2
1847	1		1							1				3
1848	1	1		2								2		6
1849		1												1
1850									1					1
1851				1										1
1852		1	1											2
1854	1													1
1856	1		1											2
1859		1												1
1860	1		1											2
1861												1		1
1862	1													1
1863	1													1
1864			1											1
1865	1													1
1866			1											1
1867		1	1											2
1868	1			1	1									3
1869	3	1	3											7
1870	1													1
1871			1											1
1872		1												1
1873	1											1		2
1874		2		1							1	1		5
1875	3	1	1								1	1		7
1876	1	1	1											3
1877	2	1	2	1					1			1		8
1878	2	1												3
1879	3		2	2								1		8
1880	2	1	1											4
1881		1	1									1		3
1882	1	1	2											4
1883	2	1	2									2		7
1884	1	1												2
1885	1													1
1886	2		1											3
1887	2		1	1										4
1888		1	1										1	3
1889	1	1	3											5
1890	5	1	4								1	2		13
1891	1	4	1									1		7
1892		1										1		2
1893		1	1											2
1895	1													1
1896	1													1
1897		1												1
1898			1											1
1899												1		1
1900	1	1	1	1										4
1901	1		1	1								1		4
1902												1		1
1903	2	1	1	1										5
1904	1													1
1905	2		1											3
1906		1												1
1907				1										1
1908	1		2											3
1909				1										1
1910			1									1		2
1911	1											1		2
1912	1													1
1913		1	1	1								1		4
1914	1		2									1		4
1915	1	2	1	1										5
1916	1	1						1						3
1917			1			1						2		4
1918		1	3								1			5
1919	2	2	2	1		1	1			1		1		11
1920	2	2	2											6
1921	2	1								1	2	1		7
1922	2													2
Total	68	44	59	17	2	2	1	1	2	4	7	30	9	246

[5] *Deutsche Seewarte*, Hamburg, 1897.
[6] Knipping: Die Tropischen Orkane der Südsee, *Archiv. der Deutschen Seewarte*, 1893.
[7] Dobson: *Australian Cyclonology*, 1853.
[8] A. Schück: *Beitrage Zur Meeresjkunde, III*, Hamburg, 1906.
[9] Ralph Linton, of the Bishop Museum of Honolulu, scientific staff, oral communication.

The regions of origin of cyclones in the south Pacific according to months and location are shown in Table 3. This table is an extension of that given by Schück,[10] the approximate origin of all storms in the foregoing list not studied by him being given. As information as to exact place of origin is available for very few storms, this table gives approximate origin only.

TABLE 3.—*Region of the origin of cyclones in the south Pacific, classified according to months and locations in areas 5° square.*

[Figures following a dash (—) are of storms concerning which information is fragmentary.]

Month.		East.				West.							
	Degrees→ ↓south.	160–165	165–170	170–175	175–180	180–175	175–170	170–165	165–160	160–155	155–150	150–145	145–140	Total.
Jan.	5-10	— 1			1		1							2— 1
	10-15	1			1	2	3— 7							7— 7
	15-20	— 1	5—2	1	14— 3	—1	4— 2				1—1	—2	1	26—12
	20-25	— 2	3—1	—1		—1			—1					3— 6
	25-30		1		— 1	—1								1— 2
	30-35					—1								— 1
Total.		1— 4	9—3	1—1	16— 4	2—4	8— 9		—1		1—1	—2	1	39—29
Feb.	10-15						1	1			1			3
	15-20	3— 1	5	3	7— 2	1	2— 1				1			22— 4
	20-25	1	2			—1	1— 1			1				5— 2
	25-30	— 1	—1					—1	—1		—1			— 5
	30-35				— 1									— 1
Total.		4— 2	7—1	3	7— 3	1—1	4—2	1—1	—1	1	2—1			30—12
Mar.	10-15	— 1	1	—2	1	2	4— 1							8— 4
	15-20	— 3	6		10— 3	2	6— 2						1—1	25— 9
	20-25	5	1—1		— 1	—1	— 1							6— 4
	25-30	— 1									—1			— 2
	30-35		1			—1								1— 1
Total.		5— 5	9—1	—2	11— 4	4—2	10— 4				—1		1—1	40—20
Apr.	10-15						1— 1							1— 1
	15-20		1	1	5		3							10
	20-25		1								—1			1— 1
	25-30											—1		— 1
	30-35				1	—1	2— 1				—1	—1		3— 4
Total.			2	1	6	—1	6— 2				—2	—2		15— 7
May	15-20		1				— 1							1— 1
June	25-30		2											2
July	20-25		1											1
Aug.	25-30		1											1
Sept.	15-20		1										—1	1— 1
	20-25			—1										— 1
Total.			6	—1			1						—1	6— 3
Oct.	15-20		1											1
	20-25		2											2
	25-30		—1											— 1
Total.			3—1											3— 1
Nov.	10-15							—1						— 1
	15-20						2							2
	20-25			1										1
Total.				1			2	—1						3— 1
Dec.	5-10													
	10-15				2	1	5		—1		1			9— 1
	15-20		—1	1	6	—1	2		—1		—1			9— 4
	20-25		2		— 2		— 1							2— 3
	25-30										—1			— 1
Total.			2—1	1	8— 2	1—1	7— 1		—2		1—2			20— 9
Grand total.		10—11	38—7	7—4	48—13	8—9	37—19	1—2	—4	1	4—7	—4	2—2	156—82

[10] A. Schück, *loc. cit.*, p. 99.

Turning now to Australia and its coastal waters, longitudes 100° to 160° E., Table 4 shows the recorded tropical cyclones by years and months and Table 5 the approximate origin or place or first record, by 5°—squares by months.

TABLE 4.—*Recorded hurricanes, 100° to 160° E., Australia and adjacent waters, by years and months.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Month not given.	Total.
1839			1								1			2
1843		1		1										2
1850													1	1
1860		1												1
1861			1											1
1862	1		1											2
1867			2	1										3
1869			1	1										2
1870	1	3		1								1		6
1871			2		2						1			5
1872	1	2	1									1		5
1873				1										1
1874									1					1
1875			1									1		2
1876		2	1			1						1		5
1877		2												2
1878	1	1	2									2		6
1879	2					1								3
1880	2													2
1881	2		1											3
1882	1	1	1	1										4
1883		2												2
1884	2	2	1											5
1885	1													1
1886				1										1
1887		1	2	1						1				5
1888	1	1		1								1		4
1889		1	1				1							3
1890	2		3											5
1891			1			1								2
1892	1			1							1	1		4
1893	1	3										1		5
1894	2	1	1											4
1896	1													1
1897	1											2		3
1898		2	2	1										5
1899	1	1	2	1										5
1900			1											1
1901	1	1												2
1902		1		1										2
1903	2		1											3
1904			1	1										2
1905		1												1
1906	1		1											2
1907	2		1								1			4
1908	1	1	1	2							1	1		7
1909	2	2	1	1					2					8
1910	2		1								1	1		5
1911	1	2	2								1			6
1912	2	1	3	3		1	1				1	1		13
1913	5	2		1	1							1		10
1914	2	1	1			1			1	1		1		8
1915		2	3	1								2		8
1916	2	2	2	1	2		1		1	1	1	1		14
1917	1		2	1								2		6
1918	1	2	3	1										7
1919			3	1	1		1							6
1920		3	1	2								1		7
1921	3	1	1	1	1	2	2			1	1			13
1922	2		1											3
Total.	54	49	58	29	7	7	6	0	5	4	10	22	1	252

TABLE 5.—*Approximate origin or place of first record of tropical cyclones of Australia, classified by 5°—squares and by months.*

	E.→ Lat.	100–105°	105–110°	110–115°	115–120°	120–125°	125–130°	130–135°	135–140°	140–145°	145–150°	150–155°	155–160°	E. total.
January	10–15	1	....	1	1	1	5	3	1	2	9	5	2	31
	15–20	....	....	1	8	4	1	....	....	....	2	3	1	20
	20–25	....	....	1	....	....	....	....	1	....	....	2	1	5
Total		1	0	3	9	5	6	3	2	2	11	10	4	56
February	10–15	3	....	....	1	1	1	3	2	....	3	1	8	23
	15–20	....	....	3	7	2	....	....	1	....	....	2	3	18
	20–25	....	1	3	....	....	....	....	1	1	....	....	....	6
Total		3	1	6	8	3	1	3	4	1	3	3	11	47
March	10–15	1	1	....	1	5	4	3	1	1	3	3	7	30
	15–20	1	2	....	2	4	1	....	2	....	3	1	4	20
	20–25	....	....	2	....	....	....	....	....	1	....	....	2	5
Total		2	3	2	3	9	5	3	3	2	6	4	13	55
April	5–10	....	1	....	....	1	6	....	....	....	....	....	....	8
	10–15	....	....	1	2	2	....	1	1	....	1	....	3	11
	15–20	....	....	1	2	....	....	....	....	....	....	1	1	5
	20–25	....	....	....	....	....	....	....	....	....	....	....	2	2
Total		0	1	2	4	3	6	1	1	0	1	1	6	26
May	10–15	....	....	....	1	....	....	....	....	....	....	....	....	1
	15–20	1	....	....	....	....	....	....	....	....	....	....	2	3
	20–25	....	....	....	....	....	....	....	....	....	....	....	5	5
Total		1	0	0	1	0	0	0	0	0	0	0	7	9
June	10–15	....	....	....	....	....	....	....	1	....	1	....	1	3
	15–20	....	....	....	....	....	....	....	....	....	1	....	....	1
	20–25	....	....	....	....	....	....	....	....	....	....	1	2	3
Total		0	0	0	0	0	0	0	1	0	2	1	3	7
July	10–15	....	....	....	....	1	....	....	....	....	....	....	....	1
	15–20	....	....	....	....	....	....	....	....	....	....	....	1	1
	20–25	....	....	....	....	....	....	....	....	....	1	....	3	4
Total		0	0	0	0	1	0	0	0	0	1	0	4	6
August	None.	....	....	....	....	....	....	....	....	....	....	....	....	....
September	15–20	....	....	....	1	....	....	....	....	....	....	1	1	3
	20–25	....	....	....	....	....	....	....	1	....	....	1	....	2
Total		0	0	0	1	0	0	0	1	0	0	2	1	5
October	15–20	....	....	....	....	....	....	....	1	....	....	2	1	4
November	10–15	1	....	....	....	2	2	4	....	....	....	....	....	9
	15–20	....	....	....	....	....	....	....	....	....	1	....	....	1
Total		1	0	0	0	2	2	4	0	0	1	0	0	10
December	5–10	....	1	....	....	1	....	....	....	....	2	....	....	4
	10–15	....	....	....	1	1	1	3	1	....	....	....	1	8
	15–20	....	....	1	1	....	....	....	....	1	....	2	1	6
	20–25	....	....	....	....	....	....	....	1	....	....	1	....	2
Total		0	1	1	2	2	1	3	2	1	2	3	2	20
Grand total		8	6	14	28	25	21	17	15	6	27	26	52	245

In the bulletin referred to, the storms of this region are listed under political divisions, as Queensland, Northern Territory, and Western Australia, with supplements to each list. One supplement consists of storms which recurved to the east of Queensland, not severely damaging the coastal settlements, another supplement includes the hurricanes recorded by Doctor Braak as occurring near Timor, not far from the Northern Territory of Australia. The remaining supplement includes the hurricanes recorded by A. Schück from the easternmost portion of the Indian Ocean, between the 100th meridian and the continent. Table 6 sums up the data as to the storminess of these several areas.

TABLE 6.—*Monthly distribution of cyclones, by states.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Queensland:												
Hurricanes and cyclones	29	22	29	12	6	6	5	....	4	4	2	8
Lesser tropical disturbances	12	15	12	10	9	7	6	1	....	4	5	9
Northern Territory:												
On the mainland	7	4	8	2	....	....	....	....	....	....	4	7
Hurricanes near Timor	....	....	1	6	....	....	....	....	....	....	....	....
Western Australia:												
Mainland	21	17	15	7	....	1	....	....	1	1	2	8
In the East Indian Ocean	3	7	7	2	2	....	....	....	....	....	1	1

From Table 4 it will be seen that the main hurricane season extends from December to April, for during this five-month period about five-sixths of the storms occur. About three-fifths of the storms occur in January, February, and March. During the seven months May to November, inclusive, storms are rare, but rather evenly distributed, except that no severe tropical cyclone has been recorded in August.

Table 6 indicates that there is some difference in monthly distribution of storminess in the several divisions of Australia. In Queensland, the main hurricane season scarcely commences until January, while in Northern Territory nearly twice as many storms have been recorded in December as in February, and three times as many as in April. March is the stormiest month in Queensland, while in Western Australia both January and February are stormier than March. Indeed January has had nearly twice as many storms as March. In the region, Northern Territory, somewhat intermediate conditions occur, January and March being equally stormy. In the supplementary lists studied in Table 6 it is noticed that six-sevenths of the severe storms recorded near Timor occurred in April, while in the eastern portion of the Indian Ocean, February and March together have had nearly two-thirds of the total recorded storms.

Table 5 reveals a tendency for a seasonal variation in the place of origin of the storms under consideration. From November to April, inclusive, slightly over half of the storms are first noted in relatively low latitudes, 5° to 15° S., while in the other six months about five-sixths of the storms make their appearance in latitudes greater than 15°. The indications are also that a larger share originate in the interior of Australia (especially over the Gulf of Carpentaria) in the six months May to October than in the rest of the year.

The list of storms from which Tables 4 to 6 were compiled was obtained with the active assistance of officials of the Australian Meteorological Bureau, who not only facilitated my study of official records, the daily weather maps for the 20 years 1892–1921, and other information, but assisted in many ways. Indeed to Mr. David Hodge of the central office, Melbourne, is due much credit for the completeness of the Australian lists. The lists to appear in the bulletin are the first fairly complete lists for Australia. However, a list of 31 for Western Australia appeared in Hunt, Taylor, and Quayle: Climate and

weather of Australia, 1913, and a longer list of Queensland storms appeared in an official monograph on "Queensland rainfall data." However, tornadoes and thunder squalls as well as hurricanes, are listed together with no clear separation between these types.

As to the frequency of tropical cyclones in Australia: During the decade 1912–1921 there was an average of 62 storms a year, together with an average of about 8.5 storms which did not produce damaging gales in Queensland itself, although many caused gales at sea not far away. In Northern Territory and Western Australia the recent average of severe storms has been about 1.5 severe storms each. In near-by portions of the adjacent oceans there has been an average of fully two storms a year, bringing the total for this general region to well over a dozen notable tropical cyclones a year.

As to the course followed by the storms, a few quotations from the bulletin may be in order.

A study of the foregoing charts reveals certain tendencies:

(1) Although most of the storms move southward into higher latitudes they follow no prescribed paths, except perhaps across the southwestern part of the continent, from Onslow to the Bight and on toward Tasmania. Instead, some storms move southwest, others southeast, some even northward for a distance. Many change their direction of progression several times. The more tracks one traces, the more evident it is that the storms are influenced by changing atmospheric conditions, rather than by the unchanging relief features.

(2) Although all portions of Australia are occasionally crossed by tropical cyclones notable destruction upon the land has been almost lacking in the extreme southern parts of the continent. The section between Melbourne and Sydney appears to be especially fortunate in this regard, as does also the extreme southwestern corner of the continent.

(3) Roughly, a fourth of the storms recurve rather sharply, their tracks forming a parabola. Another fourth recurve less sharply, forming a hyperbola. In respect to about another fourth, the segment of the track traced might be one leg of a hyperbola. The remaining fourth of the tracks show no sign of curving on a parabolic course, being either almost straight, or curving irregularly.

(4) Where recurving is evident, on these charts, the apex of the recurve generally is in the tropical latitudes. In other words storms located poleward of the tropic nearly always are moving eastward or southeastward, while in the tropical portion of the continent many are moving westward. However, about as many are moving eastward or southward in the tropical parts of the continent as are moving westward.

(5) The storms of the main hurricane season, December to April, are much more likely to recurve on a parabolic or hyperbolic course than are the storms of the other months. Indeed, the storms of May to November have a strong tendency to follow rather straight courses.

(6) There seems to be a slight tendency for the storms which occur late in the year to be destructive farther south than those occurring in January to April. However, in April, Timor (latitude 7° to 10°) appears to be especially subject to hurricanes, and in December several severe storms have occurred in latitudes less than 20° from the Equator in Western Australia as well as beyond the tropic near 30° latitude in Queensland.

(7) Most storms gain speed as they progress, traveling about twice as rapidly in the subtropical portions of their course as in the tropical portions. In the Tropics their average speed is about 200 miles per day, while in latitudes above 30° their average is above 400 miles per day. The range in speed is high, however, some storms crossing northern Australia at the rate of 500 miles per day, while a few storms south of 30° travel 100 miles a day or less. The storms which occur out of the main hurricane season, namely those occurring from May to November, have a higher average speed than those of the main season, December to April.

(8) (*a*) A large share of the storms approach the coast of tropical Queensland from the east. (*b*) Another large share apparently originate to the north or northwest of the continent, and move southward along the coast of Western Australia, or else move inland. (*c*) Some storms appear to originate in the interior, especially near the Gulf of Carpentaria. Such storms move south, southeast, or west. (*d*) Many storms disappear in the interior of the continent. (*e*) A number of the storms have entered Queensland from the east, crossed it, and Northern Territory, passed far south along the western coast, then moved eastward, being evident on the daily weather map as far east as New Zealand, a distance of about 9,000 miles. In some cases, there is little evidence of marked decrease in intensity.

Finally, brief attention may be given to the tropical cyclones of the south Indian Ocean, longitudes 40° to 100° E. The storms occurring near Mauritius have been studied for many years by the various directors, notably Meldrum, of the Royal Alfred Observatory. Table 7 gives the storms, by years and months, from 1848 to 1919, recorded in the reports of this observatory as occurring in longitudes 50° to 70° E. Tables 8 and 9 give, respectively, the much less complete lists for the portions of the Indian Ocean to the west of 50° and to the east of 70°. These two tables are based on the lists given by Schück,[11] except that four storms described by Woods-Jones, from Cocos-Keeling Islands, are added.[12] Table 10 indicates the region of the origin of tropical cyclones in the entire south Indian Ocean. It is copied from Schück, and is based in part upon storms not included in the foregoing lists, because the list for longitudes 50° to 70° is different and fuller than the one he used. He also includes in this table storms in the easternmost part of the ocean (east of 100°), here considered with the Australian storms.

Of the storms listed in Tables 7, 8, and 9, January and February had 25 per cent each, March 20 per cent, April and December 10 per cent each, November 5 per cent, and May 4 per cent. Storms are lacking or extremely rare in the four months June to September. It appears that on the average rather more than a dozen tropical cyclones occur annually in longitudes 40° to 100° E.

[11] Schück, Wirbelstürme, *loc. cit.*, p. 58.
[12] F. Woods-Jones: Coral and atolls. The storms added are Jan. 25, 1876 (very severe), Feb. 4, 1893, Mar. 4, 1902, and Nov. 27, 1909 (very severe).

TABLE 7.—*Recorded tropical cyclones near Mauritius in south Indian Ocean, longitudes 50° to 70° E.*

[From reports of director of Royal Alfred Observatory, Mauritius. (1848–1902, in paper by Claxton; 1903–1919, from annual reports of director.)]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1848	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1851	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1852	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1854	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	.....	3
1855	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	2
1856	.....	1	1	1	.....	.....	.....	.....	.....	.....	1	.....	4
1857	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	1	4
1858	1	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1859	2	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	5
1860	5	2	1	.....	1	.....	.....	.....	.....	.....	.....	.....	9
1861	2	2	1	.....	.....	.....	.....	.....	.....	.....	.....	1	6
1862	2	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	4
1863	2	2	2	.....	.....	.....	.....	.....	.....	.....	1	.....	7
1864	2	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
1865	1	2	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	4
1866	1	1	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	6
1867	1	1	.....	1	1	.....	.....	.....	.....	.....	1	.....	5
1868	2	1	1	1	1	.....	.....	.....	.....	1	.....	.....	7
1869	1	2	1	.....	1	.....	.....	.....	.....	.....	1	.....	6
1870	1	1	1	1	.....	.....	.....	.....	.....	.....	.....	1	5
1871	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	3
1872	1	2	2	1	2	.....	.....	.....	.....	.....	1	.....	9
1873	2	2	1	.....	.....	.....	.....	.....	.....	1	1	.....	7
1874	3	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
1875	3	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	5
1876	2	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	6
1877	2	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	4
1878	2	1	.....	1	.....	.....	.....	.....	.....	.....	.....	1	5
1879	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	2	5
1880	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	4
1881	2	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1882	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1883	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	3
1884	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	1	4
1885	2	1	1	.....	1	.....	.....	.....	.....	.....	.....	2	7
1886	.....	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	3
1887	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1888	1	3	1	.....	.....	.....	.....	.....	.....	.....	.....	1	6
1890	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	3
1891	3	2	1	.....	.....	.....	.....	.....	.....	.....	1	.....	7
1892	1	3	.....	1	1	.....	.....	.....	.....	.....	.....	.....	6
1893	2	1	1	1	.....	.....	.....	.....	.....	.....	1	1	7
1894	1	2	2	1	.....	.....	.....	.....	.....	.....	.....	2	8
1895	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2
1896	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1897	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	2	5
1898	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	3
1899	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2	4
1900	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1901	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	4
1902	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	7
1903	3	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
1904	.....	2	1	1	.....	.....	.....	.....	.....	.....	.....	1	5
1905	2	1	3	1	.....	.....	.....	.....	.....	.....	.....	1	8
1906	1	1	1	1	.....	.....	.....	.....	.....	.....	.....	1	5
1907	.....	1	1	2	1	.....	.....	.....	.....	.....	1	2	8
1908	1	3	2	1	.....	.....	.....	.....	.....	.....	.....	.....	7
1909	2	1	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
1910	1	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1911	1	1	3	.....	.....	.....	.....	.....	.....	.....	2	1	8
1912	1	4	1	.....	1	.....	.....	.....	.....	.....	1	.....	8
1913	3	3	2	2	.....	.....	.....	.....	.....	.....	.....	2	12
1914	4	1	2	1	1	.....	.....	.....	.....	.....	.....	.....	9
1915	.....	2	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
1916	2	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	4
1917	1	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
1918	1	2	1	1	.....	.....	.....	.....	.....	.....	.....	.....	5
1919	2	2	1	.....	1	.....	.....	.....	.....	.....	.....	.....	6
Total	94	89	70	30	14	0	0	0	0	3	15	36	351

TABLE 8.—*Recorded tropical cyclones in the south Indian Ocean between Africa and 50° E., by years and months.*

[From Schück: Zur Kenntnis der Wirbelstürme, p. 58.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1851	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1852	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1858	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
1859	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2
1863	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1865	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1869	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1870	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1872	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1873	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1874	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1876	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1877	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1879	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
1885	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1901	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Total	6	5	3	1	0	0	0	0	0	0	0	2	17

TABLE 9.—*Recorded tropical cyclones, 70° to 100° E., in the south Indian Ocean, by years and months.*

[From Schück: Zur Kenntnis der Wirbelstürme, p. 58.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1848	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	3
1851	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
1852	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1854	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
1855	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	2
1857	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
1858	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	2
1859	1	.....	1	1	.....	1	.....	.....	.....	.....	.....	1	5
1860	2	2	2	1	1	.....	.....	.....	.....	.....	.....	1	9
1861	2	1	1	2	.....	.....	.....	.....	.....	.....	1	2	9
1862	2	2	2	.....	.....	.....	.....	.....	.....	.....	.....	1	7
1863	.....	1	.....	1	1	.....	.....	.....	.....	.....	1	.....	4
1864	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	3
1865	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	3
1866	.....	.....	1	3	3	.....	.....	.....	.....	.....	1	.....	7
1867	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1868	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	2
1869	.....	2	.....	1	.....	.....	.....	.....	.....	.....	1	1	5
1870	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
1871	2	1	1	.....	.....	.....	1	.....	.....	.....	1	.....	6
1872	.....	3	1	.....	1	.....	.....	.....	.....	.....	.....	.....	5
1873	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1874	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
1875	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1876	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2	4
1877	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	2
1878	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1
1880	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1881	1	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	4
1882	1	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	4
1883	.....	1	2	.....	.....	.....	.....	.....	.....	.....	2	.....	5
1884	.....	1	2	.....	.....	.....	.....	.....	.....	.....	1	.....	4
1885	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	3
1886	.....	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2
1893	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1901	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1902	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1909	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Total	21	27	27	18	6	1	1	0	0	0	10	12	124

TABLE 10.—*Region of the origin of cyclones in south Indian Ocean, classified according to months and location in areas 5° square (1848–1905).*

[From A. Schück, Beiträge zur Meereskunde, 1906, p. 59.]

Month.	°S.	30–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75	75–80	80–85	85–90	90–95	95–100	100–105	105–110	110–115	115–120	120–125	Total.
January	5–10					2	2		1		3—1	1								9— 1
	10–15					6—2	2	2	1	5	1—1	2—1			1					20— 4
	15–20				2—1	7—1	6	1		2	1								1	20— 2
	20–25				2—2	1	1—1				—1						—1			4— 5
	25–30	—1		1		—2	—1							—1						1— 5
	30–35			1—1		—2														1— 3
Total			—1		2—1	4—3	16—7	11—2	3	2	7	5—3	3—1		—1	1		—1		1	55—20=75
February	5–10									1		2			—1					3—1
	10–15					7	2	2	2	5	1	1	2		1	1				24
	15–20				1—1	4—1	2	3	1	2	3			1			1		1	19—2
	20–25			—1	—1				2				1			1		—1		4—3
	30–35				1—1															1—1
Total				—1	2—3	11—1	4	5	5	3	4	3	3	1	1—1	2	1	—1	1	51—7 =58
March	0– 5												1							1
	5–10							1			1	3	—1							5— 1
	10–15			1		1	2—1		2	2	2	3	2—1		1					16— 2
	15–20		—1		1—2	1—1	2—1	5—1	1	1	1				1	1—1				14— 7
	20–25			—1	1—1	—1	1	—1					—1					—1		2— 6
	25–30					—2		—1	—1		—1									— 5
	30–35				—1												—1			— 2
Total			—1	1—1	2—4	2—4	5—2	6—3	3—1	3	4—1	6	3—3		2	1—1	—1	—1		38—23=61
April	0– 5											1								1
	5–10	—1					—1	1		1—1	1—1	5—3	1—2			1				10— 9
	10–15			1		—1		1	3	1—1	3		1	—1						10— 3
	15–20				2		2—2	1		—1		—3					—1			5— 7
	20–25					1				—1										1— 1
	25–30				—1															— 1
	30–35	—1		—1			—1													— 3
Total			—2		1—1	2—1	1—1	2—4	3	3	2—4	4—1	6—6	2—2	—1		1	—1			27—24=51
May	0– 5														—1					— 1
	5–10								1			2	1	1						5
	10–15							2				—1						—1		2— 2
	15–20				—1	—1	—1	1			—1				—1					1— 5
	25–30				—1	—1														— 2
	30–25					—1	—1													— 2
Total					—2	—3	—2	3	1		—1	2—1	1	1—1	—1			—1		8—12=20
June	0– 5											—1	—1							— 2
	5–10											1								1
Total												1—1	—1							1— 2= 3
July	0– 5												1	1						2
August and September (no report)																				
October	0– 5						1													1
	5–10												—1							— 1
	15–20					—1		1												1— 1
	20–25						—1													— 1
	25–30	—1																		— 1
Total			—1				—1	1—1	1				—1							2— 4= 6
November	0– 5											—1	—1		1					1— 2
	5–10								1	1		2—2	1—2							5— 4
	10–15					—1			1		—1	2								3— 2
	15–20												—1							— 1
	25–30			—2	1—1															1— 3
	30–35						—1													— 1
Total				—2	1—1	—1	—1		2	1	—1	4—3	1—4		1					10—13=23
December	5–10											4	2			—1				6— 1
	10–15		1	—1		—1	2	4	1	1			1—1							10— 3
	15–20					2—1	4	1	1		—1								1	9— 2
	20–25			—1	—1															— 2
	30–35				—1		—2													— 3
Total			1	—2	—2	2—2	6—2	5	2	1	—1	4	3—1			—1			1	25—11=36

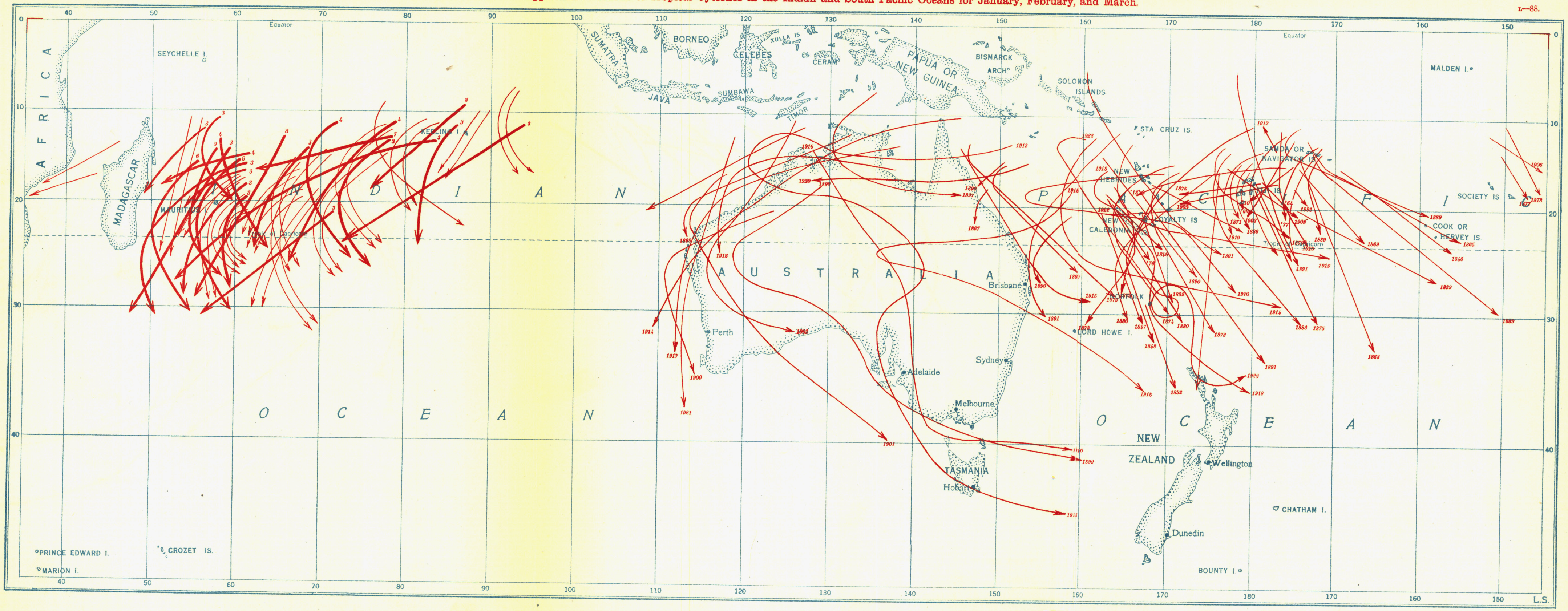
Table 11 summarizes certain data as to the tropical cyclones in the half of the southern Tropics here under consideration.

TABLE 11.—*Summary as to tropical cyclones of half of Southern Hemisphere.*

Region.	Number of recorded cyclones.	Extremes length of record.	Number of years in which hurricanes are recorded.	Probable annual frequency.	Percentage of storms occurring in December to April.
South Pacific (160° E. to 140 W°.)	246	1784–1922	87	12	90
Australia (100° to 160° E.)	252	1837–1922	60	12	84
South Indian Ocean:					
40° to 50° E.	17	1851–1901	16		
50° to 70° E.	351	1848–1919	68		
70° to 100° E.	124	1848–1909	38		
Indian Ocean	488	1848–1919	68	12	90
Grand total (40° E. to 140° W.)	980	1789–1922	190	36	88

Representative tracks are shown on Charts I and II. The tracks of storms crossing Australia or vicinity were nearly all traced by the writer from the daily weather maps for 1892–1921. The track of the 1922 storm has been supplied by Director Hunt of the Australia Meteorological Bureau. Many of the tracks given in the author's bulletin on Australian hurricanes, already mentioned, are omitted for lack of space. About two-thirds of the tracks in the south Pacific are those given by Knipping in Bartholemew's *Atlas of Meteorology*. The other third were traced by the author from information gathered in Fiji and elsewhere, or from the records of the Australian Weather Bureau. The notable storm of March, 1910, which damaged several island groups, is charted in Hunt Taylor, and Quayles' Climate and Weather of Australia. The Knipping tracks have been dated. In Bartholemew's Atlas they are not dated. The dates were obtained from the *Segelhandbuch für den Stillen Ozean*, 1897. The south Indian Ocean tracks are mostly those given by

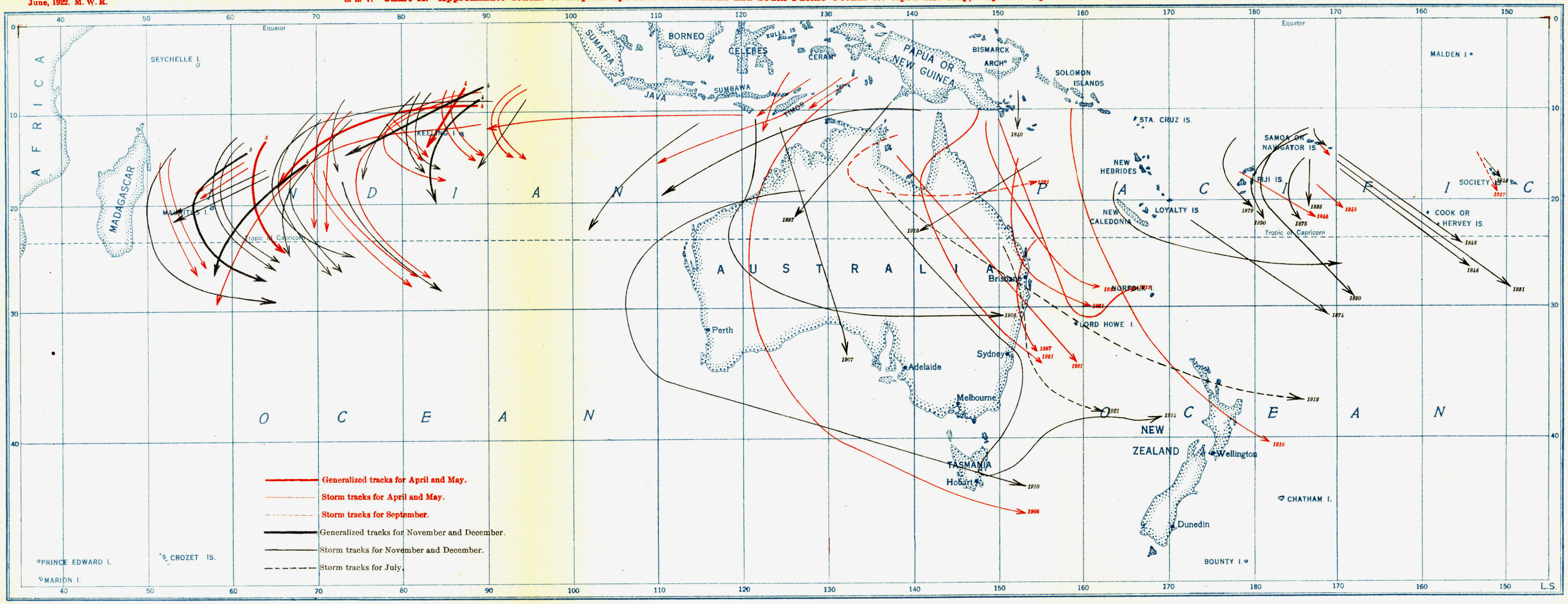
S. S. V. **Chart I.—Approximate Tracks of Tropical Cyclones in the Indian and South Pacific Oceans for January, February, and March.**



June, 1922. M. W. R.

S. S. V. **Chart II.—Approximate Tracks of Tropical Cyclones in the Indian and South Pacific Oceans for April and May, July and September, and November and December.**

L.—89.



Köppen in Bartholomew's *Atlas*, which in turn were generalized from Meldrum, long director of the Mauritius Observatory. The wider lines indicate that three or more storms followed approximately that course in a 35-year period. The numeral at the end of the line indicates the number of storms along that track in that period. Koppen's charts have been combined and modified to aid in legibility and have been supplemented by several notable tracks shown in *Ein Atlas für den Indischen Ozean, Deutsche Seewarte*, 1891. The latter tracks are dated as to month, though not as to year. Köppen's tracks are dated only as to season, November and December, January to March, and April to May.

This chart and foregoing data lend little support to the oft-repeated generalization that tropical cyclones originate in a few restricted areas on the western sides of oceans at the time when the doldrums are farthest from the Equator. Many other widely accepted generalizations as to tropical cyclones appear unsafe in the light of the fuller data being gathered.

TROPICAL CYCLONES IN THE NORTHEAST PACIFIC, BETWEEN HAWAII AND MEXICO.

By STEPHEN S. VISHER.

[Indiana University, Bloomington, Ind.]

Redfield, in his paper on cyclones of the Pacific, forming a part of Commodore Perry's *Narrative of Expedition to Japan*, devotes six pages to the northeast Pacific,[1] and presents a chart showing the approximate tracks of 13 cyclones mostly in the region just west of Mexico, but partly near Hawaii. In the *Segelhandbuch für den Stillen Ozean*[2] there is a list of 45 storms occurring in that region between 1832 and 1892, no mention being made however, of those described by Redfield.

No mention of tropical cyclones occurring in this region between 1892 and 1915 has come to light except that the courses of six are traced by Hurd.[3]

Severe storms occurring in September, 1915 and September, 1918, are described in the MONTHLY WEATHER REVIEW.[4]

Since August, 1921, brief mention of four tropical cyclones has been made in the same journal.[5]

The following list includes the 70 storms mentioned in these sources of information:

List of tropical cyclonic storms in the northeast Pacific (west of Mexico and Central America and east of the longitude of the Hawaiian Islands.)

Year.	Month.	Place of origin, or first record.		Source of information.
		North latitude.	West longitude.	
		°	°	
1832	December	13	148	D. S. H.
1839	Nov. 1	23	106	D. S. H.
1840	....do	22	105	D. S. H.
1842	October	15	95	D. S. H.
1843	Sept. 23	15	139	Redfield.
1847	Oct. 24	17	[a] 106	Redfield.
1849	June 21-22	16	116	Redfield.
1850				Redfield.
1850	June 24	16	107	Redfield.
1850	Aug. 5	14	[b] 117	Redfield.
1850	Sept. 9-11	15	100	Redfield.
1850	Sept. 26	26	123	Redfield.
1850	Oct. 1-6	18	104	Redfield.
1850	Oct. 3	14	[c] 117	Redfield.
1850	October	17	105	D. S. H.
1851	Sept. 16	15	120	D. S. H.
1851	October	21	107	D. S. H.
1851	Oct. 21	22	[d] 110	Redfield.
1852	July 16-19	15	[e] 115	D. S. H.
854	Oct. 5	28	135	D. S. H.

[a] NNE.
[b] From N.-W.-S.
[c] SW.-SE.-E.-N.-W.-SW.
[d] SE.-NE.
[e] From N.

[1] William C. Redfield: Vol. II, 1856, Sen. Doc. 79, pp. 354-359.
[2] *Deutsche Seewarte*, Hamburg, 1897, p. 269.
[3] Willis E. Hurd: Cyclonic storms and typhoons of the north Pacific, article on the reverse of *Meteorological Charts of the north Pacific*, U. S. Weather Bureau, January, March, and April, 1913.
[4] J. H. Kimball: A Pacific hurricane of September, 1915; MO. WEATHER REV., vol. 43, p. 486; and F. G. Tingley: Tropical cyclone of Sept. 14-17, 1918, just west of Mexico; MO. WEATHER REV., 46; 568.
[5] F. G. Tingley, MO. WEATHER REV., 49; 518, 579, 581; and 50; 99.

List of tropical cyclonic storms in the northeast Pacific (west of Merico aad Central America and east of the longitude of the Hawaiian Islands—Con.

Year.	Month.	Place of origin, or first record.		Source of information.
		North latitude.	West longitude.	
		°	°	
1855	June	20	105	Redfield.
1855	Aug. 3-6	18	109	D. S. H.
1855	Aug. 8-9	15	[f] 117	Redfield.
1855	Sept. 4	20	[g] 122	Redfield.
1857	June 20	11	110	D. S. H.
1857	Sept. 6	19	121	D. S. H.
1858	Aug. 17	13	115	D. S. H.
1858	Nov. 21	21	174	D. S. H.
1859	Sept. 10	16	99	D. S. H.
1865	July 25	10	109	D. S. H.
1870	June 17	16	106	D. S. H.
1870	Sept. 21-24	17	141	D. S. H.
1871	July 3	16	117	D. S. H.
1874	Nov. 19	16	161	D. S. H.
1877	Nov. 5	14	123	D. S. H.
1880	July 6	20	120	D. S. H.
1880	Oct. 13	18	111	D. S. H.
1882	July 31	13	118	D. S. H.
1882	Sept. 7	14	105	D. S. H.
1883	Sept. 21-23	20	105	D. S. H.
1883	Oct. 3	23	108	D. S. H.
1884	Sept. 28-30	17	107	D. S. H.
1884	Oct. 23	24	107	D. S. H.
1885	July 31	20	130	D. S. H.
1885	Sept. 12	23	128	D. S. H.
1885	Oct. 5-6	24	108	D. S. H.
1885	Oct. 25	21	106	D. S. H.
1886	Sept. 19	16	95	D. S. H.
1887	July 6	20	114	D. S. H.
1887	Oct. 3-6	17	107	D. S. H.
1888	Aug. 9-10	15	120	D. S. H.
1888	Aug. 13-14	12	120	D. S. H.
1888	Sept. 10-11	17	106	D. S. H.
1888	Sept. 20	23	107	D. S. H.
1889	Aug. 2-3	14	122	D. S. H.
1890	Aug. 18-19	16	124	D. S. H.
1891	Aug. 2	16	118	D. S. H.
1891	Aug. 7	11	107	D. S. H.
1892	July 19	20	117	D. S. H.
1902	Dec. 23-Jan. 2	21	158	Hurd.[h]
1904	Nov. 26-Dec. 4	18	161	Hurd.
1904	Dec. 23-30	15	156	Hurd.
1906	May 3-10	12	152	Hurd.
1906	Oct. 2-9	18	154	Hurd.
1906	Nov. 6-13	20	157	Hurd.
1915	Sept. 4	15	110	M. W. R., 43;-486.
1918	Sept. 15-16	18	105	M. W. R., 46;-568.
1921	Sept. 24-30	20	105	M. W. R., 49;-518.
1921	Oct. 4	22	156	M. W. R., 49;-579.
1921	Oct. 9	17	102	M. W. R., 49;-581.
1922	Feb. 1			M. W. R., 50;-99.

[f] NE.-NNW.-WNW.-SW.
[g] SE.
[h] W. E. Hurd: Article, Cyclonic storms and typhoons of the north Pacific, U. S. Weather Bureau, January, March, and April, 1913.

The monthly distribution of these storms is shown in Table 1. All but two have occurred in the six-month period June to November, inclusive. September with 28 per cent is the stormiest month, but October with 25 per cent is only slightly behind.